Space Weather Technical Forecast

Issued on Thursday, 04 July 2024 at 13:06 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity measured at GOES16 was Low, with occasional low-level C-class activity from several well-spread active region sources.

There are currently eight sunspot regions on the visible disc, and perhaps signs of an arriving ninth over the southwestern limb in EUV. Perhaps foremost amongst the current regions on the disc has been AR3733 in the northwest, with a tenuous delta spot now perhaps visible in the trailing group, and with its penumbral area increasing in the 24 hours. Also of note was AR3732 in the southwest, which saw growth of its leading spots, while 3729 showed some consolidation as a relatively open F-group. All other groups were apparently stable or weakening.

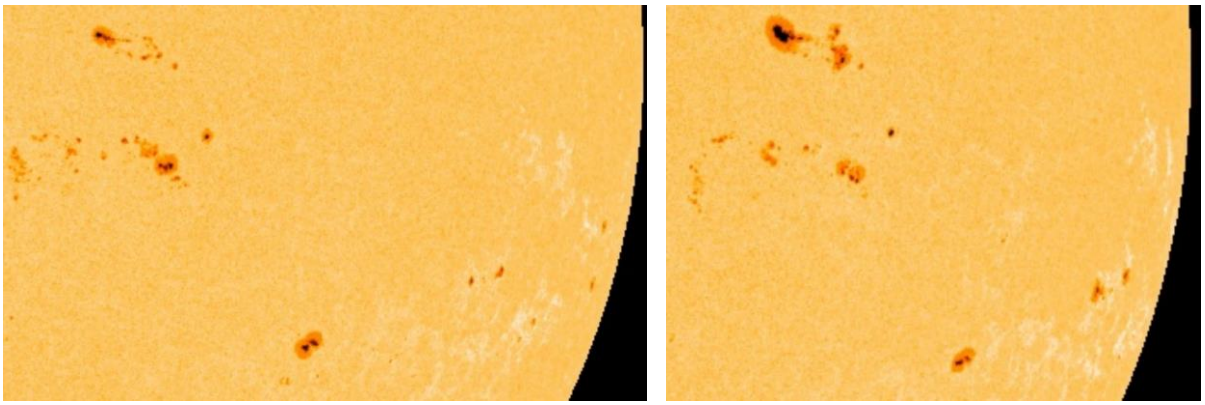

Figure 0: 24-hour change in HMIIF to 04/1030UTC showing the southwest disc. Most notably amongst these regions is the areal growth of AR3733, but also perhaps the slight simplification of AR3729.

A narrow, southwest-directed CME was seen into the start of this 24-hour period leaving AR3730, followed around 03/1500UTC by a far-sided emission also heading southwest. Neither is expected to affect Earth. A filament eruption was detected in H-Alpha imagery (e.g. Learmonth) at 04/0700UTC from the central-west disc, and perhaps another at 04/0945UTC. There is no confirmatory coronagraph imagery available at the time of writing as to whether these left the immediate solar environment or not - this will be monitored in the coming hours. No Earth-directed Coronal Mass Ejections (CMEs) have been observed in imagery during the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds as observed by ACE at L1 were at Background, but with a discontinuity of uncertain provenance seen at 03/1550UTC. This event did not neatly fit any mechanism, with the IMF decreasing but many other solar wind measures rising slightly. This may perhaps have been interaction with the edge of the shock from the 29 June CME, but this is a very tentative diagnosis, and it was in any case not impactful in terms of

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geomagnetism.

Solar wind speeds showed a rise and fall within Background levels as a result, from 325km/s to 400 and back again over the period. The solar wind density mainly rose through single figures ppcc, but was again within usual background levels. The IMF ranged to 9nT, with the north-south component +4 to -7nT, with the peak of other measures coinciding with a lull in IMF. The phi angle was mainly positive (away from the Sun).

The net result of the above solar wind measures was for Quiet to Unsettled geomagnetic indices, with a provisional peak of Kp '3-' in the 03-06UTC interval.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES18 remained at Background levels, perhaps with a very slight 10MeV enhancement in the wake of M-class activity preceding the current 24-hour period (although still well below 1pfu).

High energy electron flux (greater than 2MeV) observed by GOES16 was mostly at Moderate levels but briefly reached High, with a peak of 1190pfu at 03/1905UTC. The 24-hour fluence remained below Active on a rising trend, with 3.79e7 integrated pfu observed at 04/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a flat daily Chance of further isolated M-class flares, perhaps most likely from AR3733. Upcoming sunspot region arrivals over the eastern solar horizon in the period should help compensate for western limb losses.

Solar Wind / Geomagnetic Activity: The 29 June southwest filament CME has now most likely missed Earth to (minimal or) no effect. No further CMEs feature in the forecast.

The sole fast wind due in the period may feature over the coming UTC weekend, however this is not expected to be particularly marked and perhaps offers a Slight Chance of Active intervals, with the forecast otherwise Quiet.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at Background levels.

High energy electron flux is most likely to continue to peak at Moderate or perhaps High levels over the coming days, with a gradual decreasing trend. There is a falling daily Slight Chance of reaching Active electron fluence.

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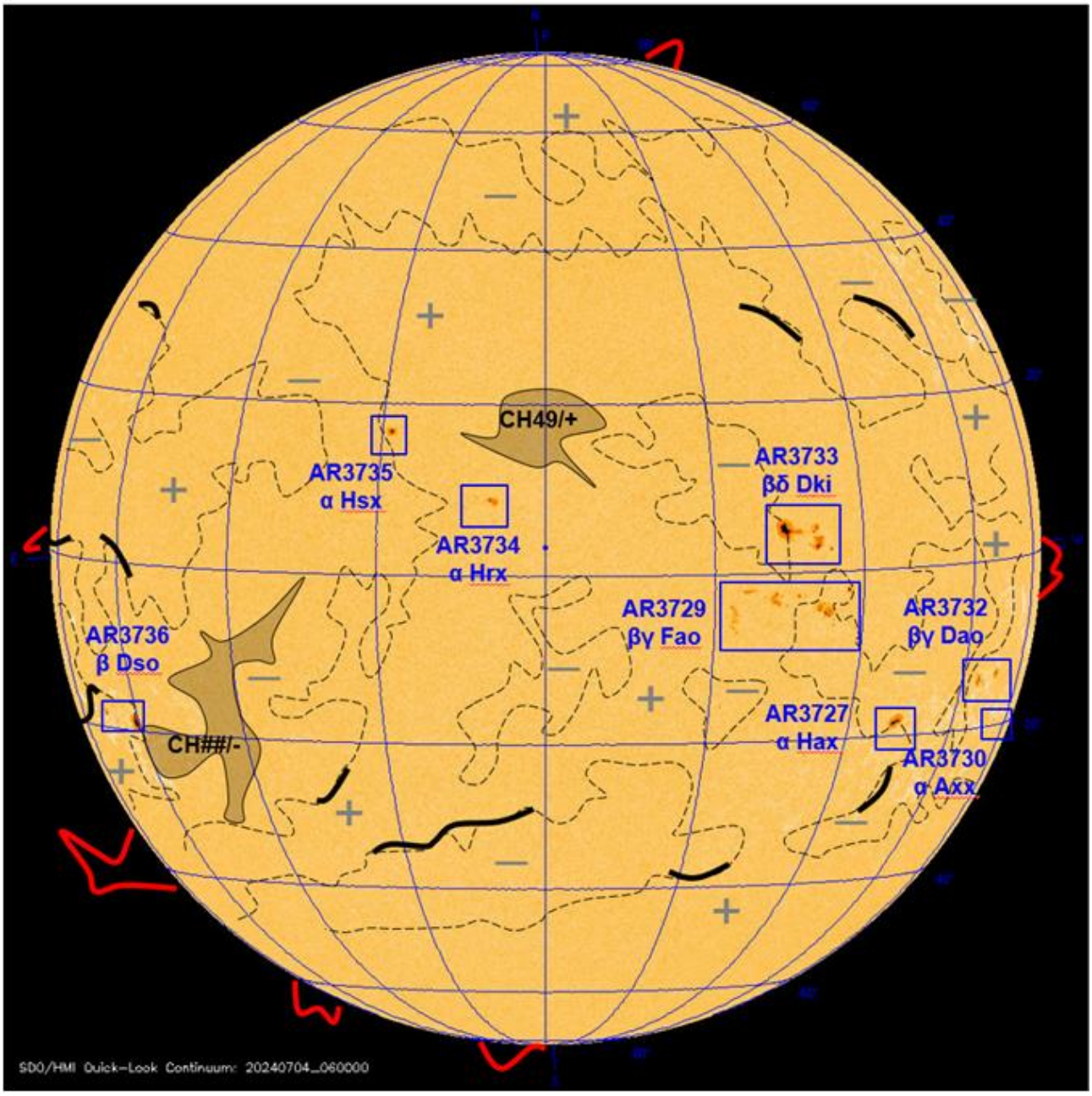
Figure 1. Solar Analysis Valid 04/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The awaited southwestern filament lift-off and CME from 29 June is now considered most likely to have missed Earth, now being outside MOSWOC modelling estimates and also the available international consensus for arrival times (including error bars). No Earth-directed CMEs now feature.

In the likely absence of any CME arrival, the solar wind may now follow a slow regime throughout the four-day period. The main uncertainty in this regard is a returning but now very tenuous coronal hole (49/+ near centre-disc). This has apparently further closed in EUV (e.g. AIA211) in the past 24-hour period, being increasingly eclipsed by bright flux to its east. Even with this trend, the emanating and potentially Earth-affecting solar wind from CH49/+ will have departed prior to this occurring and this is the basis for maintaining a small chance of slightly elevated or perhaps elevated wind speeds either late day 3 or early day 4 (06 or 07 July).

Geomagnetic activity may persist Quiet through the four days, with the greatest chance of departure from this being over the UTC weekend, with a (peak for the period) Slight Chance of Active intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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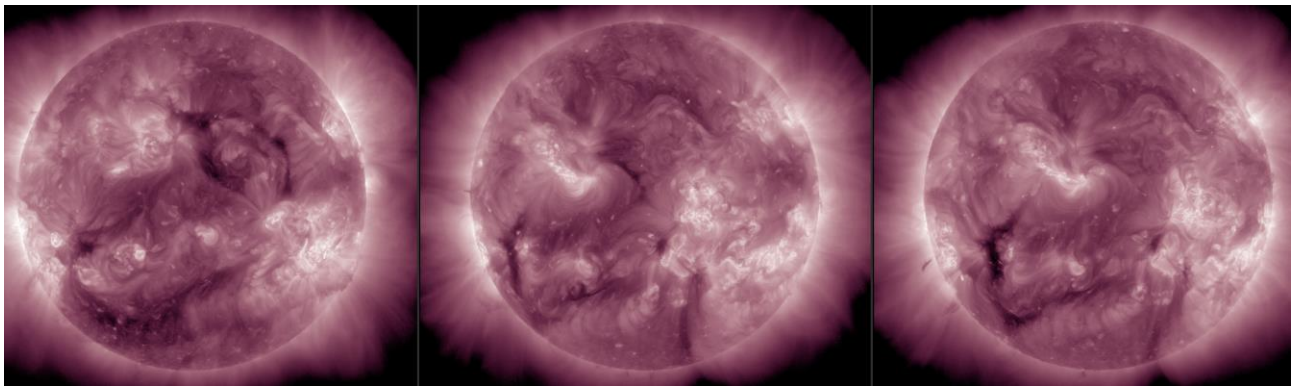
Figure 2: AIA211 imagery from 07 June (D-27); 03 June (D-1) and 04 June 1030UTC, showing the evolution of CH49/+ and comparing it to its predecessors. Its current form is the weakest (north centre-disc), and any impact arising over the coming UTC weekend is now considered to be slight.



Radio Blackouts - X-Ray Flares:

There are now relatively fewer front-sided regions on the disc when compared with the first half of the current UTC week, and those that are present have fallen relatively quiet in the past 24 hours. The main points of note have been a marked penumbral areal growth in AR3733 in the northwest, with a tenuous delta spot now perhaps visible in its trailing group. Also of note was AR3732 in the southwest, which saw growth of its leading spots, while 3729 showed some consolidation as a relatively open F-group. All other groups were apparently stable or weakening.

The recent growth in AR3733 is the main rationale for maintaining the daily 40% Chance of M-class activity despite the scant observational record, however this may be revised downwards should this growth cease.

The eastern solar horizon now appears to be harbouring a returning region in the southern solar hemisphere, with flux looping visible here on AIA094 and 171 - this is perhaps most likely to be Ex-AR3711. A few further returning regions may also manifest later in the UTC weekend as the western facing side gradually depopulates, leading to an overall relatively flat Chance of M-class flares in the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	1	1	1	1

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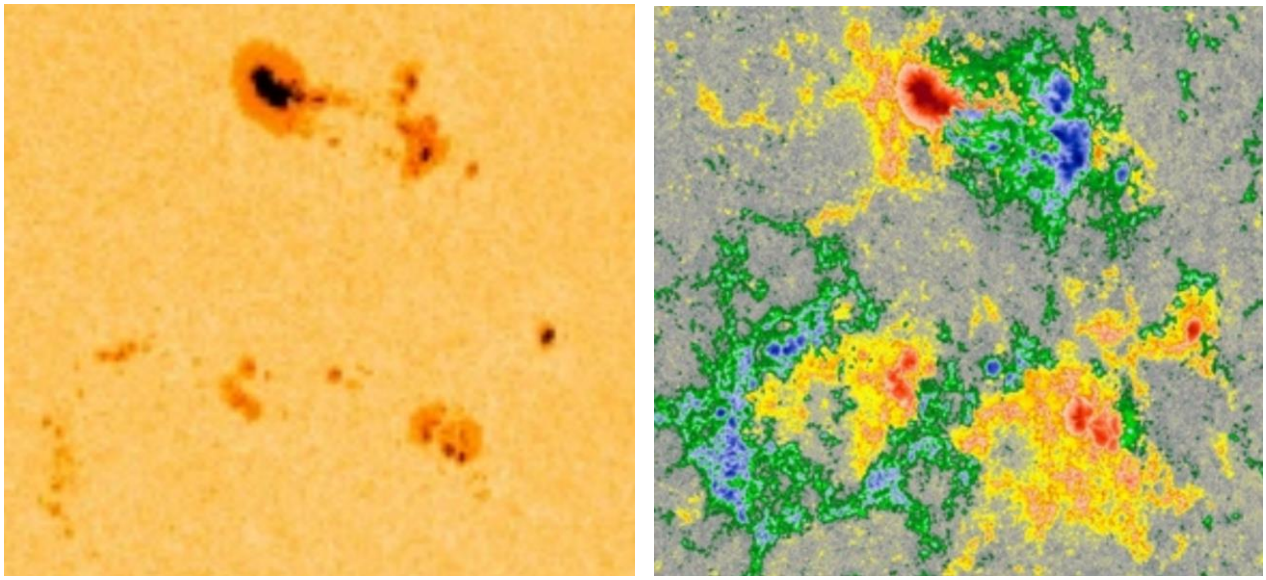
Figure 3: HMIIF and HMIBC of AR3733 and 3729 (south) at 04/1030UTC, showing possible tenuous delta in the fomrer as small spots and pores move closer to the main penumbral spot.



Solar Radiation Storms - (High Energy Protons):

There has been little recent response in GOES18 high energy proton flux measurements to low-level M-class flares of late, with perhaps the solar exception of a very minor enhancement to greater than 10MeV protons in the wake of the M1.5 03/0741UTC (albeit still peaking comfortably within background levels).

Many of the more complex sunspot regions on the disc are now nearing the better-connecting western portion of the disc, however the dearth of recent flares or precursor activity is leading to a relatively flat daily Slight Chance of S1 or greater as these groups round the limb.

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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Figure 4: Past 72 hours to 04/1030UTC in GOES16 X-ray flux (top) and resultant GOES18 high energy proton flux (bottom). Note the very slight enhancement in the wake of the M1.5 flare in 10MeV protons.

High Energy Electrons Event (≥ 2MeV):

The new calendar month has seen a day-on-day rise in high energy electron flux recorded at GOES16, although the current diurnal trend appears to show that this has saturated at mainly Moderate levels with a peak near the High threshold.

With the strong possibility of no further drivers for increasing electron populations in the period, the most probable evolution is for a very slow erosion of the current GOES16 trace in the slow solar wind environment. The main question mark as to this continuing is the possible presence of CH49/+ over the UTC weekend, with uncertainty increasing as levels perhaps take a temporary dip at GEO, with a uncertain but probably muted recovery in fluence into the new UTC working week.

GEO Electron Environment	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	5	1	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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